ENVIRONMENTAL RESOURCES MANAGEMENT GROUP

FINAL REPORT

Aubrey Manufacturing, Inc.

Corrective Action Status Report and Work Plan Addendum No. 3

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Project No. 2060

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1.0 *INTRODUCTION*

This Corrective Action Status Report and Work Plan Addendum No. 3 is for the closure of the former Resource Conservation and Recovery Act (RCRA) hazardous waste surface impoundment treatment unit (TO2) at the Aubrey Manufacturing, Inc. (Aubrey) facility in Union, Illinois (Figure 1). This document presents:

- The results of the ground water investigation activities performed pursuant to the approved Corrective Action Work Plan (the "Work Plan"), Corrective Action Status Report and Work Plan Addendum No. 1 (the "Addendum No. 1"), and the Corrective Action Status Report and Work Plan Addendum No. 2 (the "Addendum No. 2"),

- The applicable Tier I remediation objectives for the ground water plume,

- An updated Tier 3 evaluation of the risk posed by the ground water plume,

- A request to collect and evaluate additional ground water monitoring data before establishing the ground water management zone (GMZ), alternative ground water standards, and institutional controls for the site, and

- A proposed scope of work for continuing to monitor the ground water plume until the applicable Tier I remediation objectives are achieved and the Illinois Environmental Protection Agency (IEPA) approves clean closure of TO2.

This document is intended to be a request for an RCRA closure plan modification. The ground water investigation work described in this document was proposed in the Work Plan (ERM EnviroClean, 1996), Addendum No. 1 (ERM EnviroClean, 1997a), and Addendum No. 2 (ERM EnviroClean, 1997b). The work was performed during the third and fourth quarters of 1997 and the first and second quarters of 1998. Aubrey retained ERM EnviroClean to perform the closure activities for the former surface impoundment.

2.0 STATUS REPORT

The status report section of this document describes the investigation activities completed since the submittal of Addendum No. 2 and the results and evaluation of those activities. ERM EnviroClean used the document "Recommended Contents of RCRA Soil and/or Ground Water Investigation Reports" as a guide for preparing this section.

2.1 DESCRIPTION OF WORK PERFORMED

2.1.1 Task 2 - Monitoring Well Installation

The installation of six additional monitoring wells for the purpose of monitoring contaminant concentrations in the ground water plume interior was proposed in Addendum No. 2 and approved by the IEPA in a letter dated January 2, 1998. As shown on Figure 2, the proposed monitoring wells were to be installed on property owned by the Village of Union, Illinois.

Aubrey placed a request with the Village of Union Board of Trustees to access the right-of-way on the east side of Main Street for the purpose of installing the six monitoring wells. In February 1998, the Village of Union Board of Trustees denied Aubrey's request for access and asked that Aubrey not pursue the matter further with the Village. As such, ERM EnviroClean re-evaluated the need for the additional monitoring wells. An analysis of the ground water data obtained during the past year has demonstrated that the existing monitoring well network is sufficient to show degradation of the chlorinated solvent plume is progressing and additional data from the area of the proposed monitoring wells are unnecessary.

2.1.2 Task 3 - Ground Water Sampling and Analysis

The ground water sampling and analysis activities (Task 3 of Addendum No. 2) performed by ERM EnviroClean from the third quarter 1997 through the second quarter 1998 included:

- The measurement of static water levels in all of the monitoring wells to assess the direction and gradient of ground water flow,

- The collection and field analysis of ground water samples from select monitoring wells to assess biodegradation activity, and

- The collection and laboratory analysis of ground water samples from select monitoring wells to assess the ground water quality.

The sampling and analysis activities generally were performed in accordance with the procedures specified in the Closure Plan, subsequent correspondence with the IEPA, and Addendum No. 2. There were no major deviations from the specified procedures, and the minor deviations are described in the quarterly Ground Water Monitoring Reports (ERM EnviroClean, 1997c, 1998a, 1998b, and 1998c). Figure 1 shows the locations of the monitoring wells at the site, and Table 1 summarizes the ground water sampling and analysis plan (including the wells to be sampled, the sampling frequency, and the analyses to be performed).

2.1.3 *Task 4 - Determination of Ground Water Standards and Ground Water Management Zone*

The Task 4 activities described in Addendum No. 2 involved collecting the data needed to determine whether the basal, lower, and western portion of the upper water-bearing intervals are Class I or Class II aquifers and then using that information to define the ground water management zone (GMZ) and the alternative ground water standards for the GMZ. Specifically, ERM EnviroClean performed ground water pumping tests in three monitoring wells on the Aubrey property to determine the sustained ground water yield for the basal, lower and western portion of the upper water-bearing intervals. The results of the pumping tests were then used to determine whether the three water-bearing intervals at Aubrey are Class I or Class II aquifers and hence, determine the applicable ground water remediation objectives for each interval. Monitoring wells MW-8D, MW-9D, and MW-9S were selected for testing because they intersect representative sections of the basal, lower and western portion of the upper water-bearing intervals, respectively. ERM EnviroClean already has determined that the eastern portion of the upper water-bearing interval is a Class I aquifer.

ERM EnviroClean conducted the pumping tests using the following procedures:

- Water levels were measured in each well prior to testing.

- A stainless steel airlift pump was inserted in the well.

- The airflow rate to the pump was increased until the maximum steady-state well yield was attained. The well yield was determined by filling a graduated cylinder of known volume over a set period of time.

- If the maximum steady-state well yield was less than 80 gallons/day for a period greater than 1 hour, ERM EnvrioClean concluded that the tested interval could not sustain a yield of 150 gallons/day (i.e., the water-bearing interval is not a Class I aquifer) and the test was ended.

- If the maximum steady-state well yield was greater than 150 gallons/day for a period greater than 2 hours, then an extended pumping test was performed by adjusting the pumping rate to 150 gallons/day and operating the pump for a period of 24 hours.

Initial pumping tests were performed in all three wells on February 19, 1998, and an extended pumping test was performed in MW-9S on March 11, 1998. As specified in Addendum No. 2, ERM EnviroClean evaluated the results of the pumping tests and determined the applicable ground water standards in accordance with the IEPA RCRA closure guidance, Appendix D, "Guidance for Demonstrating Ground Water is Class II Ground Water." ERM EnviroClean compared the ground water monitoring data from the second, third and fourth quarters of 1997 and the first and second quarters of 1998 to the applicable ground standards to: (1) delineate the GMZ in accordance with the requirements at 35 IAC 725, and (2) determine the alternative ground water standards for each water-bearing interval within the GMZ in accordance with the requirements at 35 IAC 620. However, as described in Section 2.3 of this document, ERM EnviroClean concluded that inconsistent results from certain wells provide an unacceptable degree of uncertainty in defining the extent of the GMZ and the magnitude of the alternative ground water standards.

2.2 *HYDROGEOLOGIC DATA AND INTERPRETATION*

The only new hydrogeologic data obtained since submittal of Addendum No. 2 are: (1) estimates of the sustained ground water yield for the three water-bearing intervals at the site, and (2) four additional sets of water level data from the monitoring well network. The pumping test data are included as Appendix A, and the water level data are summarized on Table 2. The new hydrogeologic data does not change our interpretation of the site geology and hydrogeology presented in Section 2.2 of Addendum No. 2.

2.2.1 *Pumping Test Results*

The pumping test for well MW-8D, which intersects the basal water-bearing interval, ran for a total of 130 minutes and yielded a total of 13 gallons (Appendix A, Table A-1). At the beginning of the test, the well yielded up to 823 gallons/day. However, after 1 hour of operation the well yield dropped sharply and stabilized at less than 80 gallons/day (Appendix A, Figure A-1). The maximum steady-state well yield for MW-8D was 79 gallons/day; therefore, the basal water-bearing interval is a Class II aquifer.

The pumping test for well MW-9D, which intersects the lower water-bearing interval, ran for a total of 103 minutes and yielded a total of 8.4 gallons (Appendix A, Table A-1). The well initially yielded up to 540 gallons/day; however, the well yield dropped sharply to less than 80 gallons/day after only 43 minutes of operation (Appendix A, Figure A-2). The maximum steady-state well yield for MW-9D was 52 gallons/day; therefore, the lower water-bearing interval is a Class II aquifer.

The initial pumping test for well MW-9S, which intersects the western portion of the upper water-bearing interval, ran for a total of 166 minutes and yielded a total of 45 gallons (Appendix A, Table A-1). The well yielded from 720 to 230 gallons/day over the entire test period, with an average yield of 432 gallons/day (Appendix A, Table A-1). The extended pumping test for well MW-9S ran for 24 hours and yielded a total of 150 gallons (Appendix A, Table A-1). As shown on Appendix A Figure A-4, MW-9S was pumped at an average rate of 150 gallons/day for the entire 24-hour test; therefore, the western portion of the upper water-bearing interval is a Class I aquifer.

2.2.2 *Ground Water Elevations*

The ground water elevations at the site for the third quarter 1997 through the second quarter 1998 are similar to the ground water elevations previously obtained at the site (Table 2). Ground water in the upper interval flowed to the east at a horizontal flow gradient of 0.018 to 0.22 ft/ft; previous data indicated ground water in the upper interval flowed to the southeast and the horizontal flow gradient ranged from 0.018 to 0.3 ft/ft. Ground water in the lower interval flowed to the northeast at a horizontal flow gradient of 0.0063 to 0.018 ft/ft; previous data also showed ground water in the lower interval flowing to the northeast and the horizontal flow gradient ranged from 0.005 to 0.036 ft/ft. Ground water in the basal interval has an apparent easterly flow direction and a horizontal gradient ranging from 0.0024 to 0.019 ft/ft, which is lower than the 0.057 ft/ft gradient previously recorded. Piezometric surface maps for the upper and lower intervals are included in the quarterly ground water monitoring reports (ERM EnviroClean, 1997c; 1998a; 1998b; and 1998c).

A comparison of the ground water elevation data taken in the upper and lower water-bearing intervals from third quarter 1997 through second quarter 1998 shows the presence of a consistent downward vertical flow gradient on the Aubrey property and a seasonally upward flow gradient near Railroad Creek.. The magnitude of the downward vertical gradient ranged from 0.012 to 0.11 ft/ft; this range of vertical flow gradients is consistent with the data from previous monitoring events. Ground water in the lower interval migrates upward and discharges into Railroad Creek on a seasonal basis, as indicated by the upward vertical gradient (-0.022) during the third quarter 1997. A comparison of the ground water elevation data taken in the upper and basal intervals shows a consistent downward vertical flow gradient. These data indicate that ground water in the basal interval does not discharge to Railroad Creek on a seasonal basis as it does in the upper and lower intervals.

2.3 *GROUND WATER PLUME DATA AND INTERPRETATION*

ERM EnviroClean used the laboratory data from the monitoring well samples obtained during the second quarter 1997 through second quarter 1998 to determine the nature and extent of the ground water plume. The data used in this assessment are valid results that satisfy the data quality objectives for this project. The laboratory report and an assessment of the monitoring data are presented in the ground water monitoring report for each quarter (ERM EnviroClean, 1997c; 1998a; 1998b; and 1998c).

2.3.1 *Ground Water Remediation Objectives*

The remediation objectives applicable to the ground water at the Aubrey site include the Class I and Class II ground water standards in 35 IAC 620.410 and the surface water quality (SWQCs) established by the Illinois Environmental Protection Agency (IEPA) for Railroad Creek to the east of the Aubrey property. The IEPA provided a list of the applicable SWQCs for Railroad Creek in a letter to ERM EnviroClean dated June 19, 1997. The letter also states that once ground water enters Railroad Creek, the SWQCs must be met and there is no provision for mixing or attenuation in the creek. As such, impacted ground water discharging to Railroad

Creek via the upper water-bearing zone to the west of the creek must achieve the SWQCs at the point of discharge. Comparing the constituent concentrations detected in the ground water plume to the SWQCs is a conservative means of assessing whether the plume poses a potential risk to the Railroad Creek.

The constituent concentrations in the basal and lower water-bearing intervals are compared to the Class II standards because: (1) the water-bearing units within these intervals are Class II materials (i.e., the sands are less than 5 feet in thickness), and (2) the pumping test data shows that the sustained ground water yield of the lower and basal intervals is less than 150 gallons/day.

The constituent concentrations in the upper water-bearing interval are compared to the Class I standards and SWQC because: (1) some of the sand and gravel deposits within the upper water-bearing interval are 5 feet or more in thickness and have a hydraulic conductivity greater than 1×10^{-4} cm/sec, (2) the pumping test data shows that the sustained ground water yield of the upper interval is at least 150 gallons/day, and (3) ground water within the upper interval seasonally discharges to Railroad Creek. Ground water within the upper interval occurs from 5 to 21 feet BGS. Although the upper 5 feet of ground water occurs above 10 feet BGS, the entire upper water-bearing interval is considered to be Class I because the ground water is vertically continuous.

The impacted aquifer is not the source of drinking water for the site or any of the neighboring properties. Furthermore, the ground water plume is not within the setback zone of any private or public water supply wells registered within the Illinois State Survey. The impacted ground water in the sand and gravel deposits of the Henry Formation discharges to Railroad Creek. Therefore, it is hydraulically separated from the ground water in the Henry Formation to the east of Railroad Creek. Based on these site features, the exposure pathways for the ground water are via: (1) ingestion of ground water from a potential future water supply well installed within the plume, or (2) ingestion or contact with the water in Railroad Creek. The ground water remediation objectives presented herein address those two potential exposure routes.

2.3.2 *Basal Water-Bearing Interval*

The ground water samples collected from the basal water-bearing interval (MW-8D and MW-17D) contained no detectable volatile organic compounds (VOCs) and no metals above the Class II standards (Table 3).

These data demonstrate that the ground water plume does not extend below the lower water-bearing interval and into the basal interval. The maximum depth of the ground water plume is 35 feet BGS, (i.e., approximately 820 feet AMSL). However, most of the ground water plume is less than 20 feet BGS (i.e., 833 to 844 AMSL).

2.3.3 *Lower Water-Bearing Interval*

Ground water samples obtained from three lower water-bearing interval monitoring wells (MW-9D, MW-13D and MW-14) contained detectable concentrations of VOCs; however, only two of the wells (MW-13D and MW-14) contained VOC concentrations exceeding the Class II standards (Table 4). The VOCs detected in the lower water-bearing interval include 1,1-dichloroethane (1,1-DCA); 1,1-dichloroethene (1,1-DCE); cis-1,2-dichloroethene (cis-1,2-DCE); trans-1,2-dichloroethene (trans-1,2-DCE); 1,1,1-trichloroethane (1,1,1-TCA); vinyl chloride; and trichloroethene (TCE). The VOCs detected above the Class II standards are TCE (83 to 250 ug/l); cis-1,2-DCE (470 to 560 ug/l); and vinyl chloride (70 to 120 ug/l).

The concentrations of the individual VOCs that exceed the Class II standards have generally decreased since the second quarter 1997. The TCE concentrations varied up to 32% during the past year, but ended the year 0% to 8% lower than the previous year. Cis-1,2-DCE decreased in concentration approximately 3.6% for the year, and vinyl chloride decreased in concentration approximately 15%. Overall, the VOC concentrations in the lower interval decreased 3.6% to 22.7% for the year.

None of the ground water samples from the lower water-bearing interval contained metals concentrations above the Class II standards (Table 4). These data are consistent with data from previous sampling events.

The distribution of contaminants and the trends in contaminant concentrations illustrated by the lower water-bearing interval data document the presence of two small isolated areas of ground water impact above the Class II standards. The areas of impact are situated in the vicinity of monitoring wells MW-13D and MW-14 within the lower water-bearing interval (Figure 3).

2.3.4 *Upper Water-Bearing Interval*

Ground water samples obtained from 10 upper water-bearing interval wells (i.e., MW-5, MW-7, MW-8S, MW-9S, MW-11, MW-12, MW-13S, MW-15, MW-16, MW-18S) contained detectable concentrations of VOCs; however, only four wells (MW-8S, MW-9S, MW-13S, and MW-18S) contained VOC concentrations exceeding the Class I standards (Table 5). The VOCs detected in the upper interval include 1,1-DCA; 1,1-DCE; cis-1,2-DCE; trans-1,2-dichloroethene (trans-1,2-DCE); 1,1,1-TCA; vinyl chloride; and TCE. The VOC detected above the Class I standards are 1,1-DCE (9 to 12 ug/l); cis-1,2-DCE (140 ug/l); vinyl chloride (2 to 35 ug/l); and TCE (5 to 480 ug/l).

The concentrations of the individual VOCs that exceed the Class I standards have generally decreased since the second quarter 1997. 1,1-DCE was not detected above its Class I standards (7 ug/l) in the second quarter 1997; however, it briefly increased to 12 ug/l in MW-13S in the third quarter 1997 and then steadily decreased to less than its Class I standard by the second quarter 1998. Overall, 1,1-DCE showed a 40% decrease in concentration for the year. Cis-1,2-DCE was only detected above its Class I standard (70 ug/l) in the first quarter 1998 sample from MW-9S, which showed a temporary increase in VOC concentrations because a pumping test was conducted in that well a few weeks prior to the first quarter 1998 sampling event. By the second quarter 1998, the cis-1,2-DCE concentrations had decreased to less than its Class I standard.

The vinyl chloride concentrations in MW-6 and MW-7 decreased to levels below its Class I standard (2 ug/l) since the second quarter 1997, and the vinyl chloride levels in MW-8S dropped by approximately 11% during the past year. Temporary increases in vinyl chloride concentrations were detected at MW-18S and MW-9S during the year, but the second quarter 1998 levels were nearly the same as the second quarter 1997 levels for those wells. The TCE concentrations in MW-18S steadily decreased from 8 ug/l in the second quarter 1997 to 5 ug/l (its Class I standard) in the second quarter 1998. MW-9S experienced a temporary increase in TCE concentration (up to 480 ug/l) in the first quarter 1998 because of the pumping test previously described; however, the TCE concentrations decreased to 71 ug/l by the second quarter 1998. Overall, the VOC concentrations in the upper water-bearing interval decreased approximately 5% over the past year.

The distribution of VOCs in the upper water-bearing interval document the presence of a single plume consisting of chlorinated solvents (Figure 4). The concentrations of chlorinated solvents generally decrease downgradient and away from the former surface impoundment. As illustrated on Figure 4, the ground water VOC plume in the upper water-bearing interval extends from the former surface impoundment approximately 1,000 feet downgradient to Railroad Creek (Figure 4). The plume is approximately 130 feet wide at the former surface impoundment and may fan out toward the east; however, the monitoring well data indicate that the upper interval plume extends to Railroad Creek with little or no lateral spreading.

Nine of the upper interval monitoring well samples (i.e., MW-5, MW-6, MW-7, MW-8S, MW-12, MW-13S, MW-15, MW-16, and MW-18S) contained dissolved metals concentrations exceeding the Class I standards (Table 5). The metals that exceed Class I standards are lead (in MW-5), chromium (in MW-13S), and nickel (in MW-5, MW-6, MW-7, MW-8S, MW-12, MW-13S, MW-15, MW-16, and MW-18S). As shown on Table 5, the elevated lead concentration is anomalous because it was detected in a field duplicate sample (MW-5D), but not in the investigative sample (MW-5) from the same sampling event (i.e., the second quarter 1998). Furthermore, the affected well (MW-5) did not exceed the Class I standard for lead during the previous 14 sampling events (ERM EnviroClean, 1998c). Similarly, chromium was detected in the third quarter 1997 sample from MW-13S at a concentration above its Class I standard; however, none of the previous four samples or subsequent three samples from that well showed elevated chromium levels. As such, there is uncertainty regarding the lead concentration in MW-5 and the chromium concentration in MW-13S.

The only metal that has been consistently detected in the upper interval monitoring well samples at concentrations above its Class I standard is nickel. Since the second quarter 1997, MW-7 and MW-8S have consistently shown elevated concentrations of nickel (140 to 370 ug/l) relative to its Class I standard (100 ug/l), and the nickel concentrations in those wells increased 35% to 48% during that period (Table 5). Nickel was detected above its Class I standard once during the past year in each of the following wells: MW-5, MW-6, MW-12, MW-13S, MW-14, MW-16 and MW-18S. However, these same wells showed nickel concentrations below its Class I standard at least once, and generally several times, during the past year. The elevated nickel concentrations detected in MW-5 and MW-6 during the past year are reasonably consistent with concentrations previously detected in those wells. However, the elevated nickel concentrations detected in MW-12, MW-13S, MW-15, MW-16 and MW-18S during the past year are inconsistent with the nickel concentrations previously detected in those wells. The inconsistent nickel concentrations may be related to the sampling procedure or natural variations in ground water chemistry. At this time, ERM EnviroClean is uncertain of the specific cause of the inconsistent data.

The recent inconsistency in the lead, chromium and nickel data produces considerable uncertainty in defining the horizontal extent of the metals-impacted ground water in the upper water-bearing zone. The data consistently document the presence of a nickel plume immediately downgradient of the former surface impoundment. However, it is unclear whether nickel-impacted water actually extends to the north (MW-12), south (MW-16), and east (MW-13S, MW-15, and MW-18S) because those wells only rarely show elevated nickel concentrations. Additionally, it is unclear whether the recent elevated lead and chromium detections are anomalous or representative of actual ground water conditions. As such, ERM EnviroClean has not prepared a ground water plume map for metals.

The distribution of constituents and the trends in constituent concentrations within the upper water-bearing interval can be summarized as follows:

- The upgradient portion of the plume (i.e., near the former surface impoundment) contains low concentrations of chlorinated solvent degradation products (1,1,-DCA; 1,2-DCE; and vinyl chloride), elevated concentrations of one parent chlorinated solvent (TCE), consistently elevated nickel concentrations, and inconsistent lead concentrations.

- The central portion of the plume (i.e., between MW-9S and Main Street) contains parent chlorinated solvents (TCE and TCA) and their degradation products (cis-1,2-DCE; trans-1,2-DCE; 1,1-DCA; 1,1,-DCE; chloroethane; and vinyl chloride) over a wide range of concentrations as well as inconsistent nickel and chromium concentrations.

- The downgradient portion of the plume (i.e., between Main Street and Railroad Creek) contains low concentrations of the parent chlorinated solvent TCE and its degradation products (cis-1,2-DCE; 1,1-DCA; and vinyl chloride), and generally low nickel concentrations.

- The sidegradient portion of the plume (near monitoring wells MW-11 and MW-12 to the north, and MW-16 to the south) contain low concentrations of parent chlorinated solvents (TCE and TCA), low concentrations of their degradation products (1,1-DCA and 1,1-DCE), and inconsistent nickel concentrations.

2.3.5 *Plume Biodegradation*

The presence of cis-1,2-DCE; trans-1,2-DCE; 1,1,-DCE; 1,1-DCA; chloroethane; and vinyl chloride in the ground water indicates that the parent chlorinated solvents (TCE and TCA) are undergoing reductive dechlorination. The concentrations of the parent chlorinated solvents (TCE and TCA) have generally decreased in the ground water since the quarterly monitoring began in the fourth quarter of 1993 (MW-9S is an exception because of the effects of the pumping test). The concentrations of their degradation products (1,1-DCA; 1,2-DCE; and vinyl chloride) also have decreased throughout the monitoring period.

ERM EnviroClean obtained dissolved oxygen (DO) and oxidation-reduction potential (ORP) measurements from the monitoring wells during the sampling events from the third quarter 1997 to the second quarter 1998. These data were used to assess biodegradation activity and reductive dechlorination conditions within the ground water plume at the Aubrey site.

DO readings obtained for the upper water-bearing interval ranged from 0.15 to 8.06 mg/l; for the lower water-bearing interval from 0.47 to 8.66 mg/l; and for the basal water bearing interval from 0.47 to 4.34 mg/l (Table 6). The lower DO levels detected in the area immediately downgradient of the former surface impoundment suggest that enhanced reductive dechlorination is occurring in that area. The DO data collected to date indicate that both aerobic and anaerobic conditions occur at the site during different times of the year.

ORP readings at the site ranged from -93 to 437 mV in the upper interval; -72 to 408 mV in the lower interval; and -5 to 408 mV in the basal interval (Table 6). The low ORP readings detected near and downgradient of MW-9S in the upper interval, and near MW-13D in the lower interval may indicated enhanced biodegradation of organic contamination in these areas.

The DO and ORP data support the conclusion that reductive dechlorination of the parent (TCE and TCA) and intermediate (cis-1,2-DCE; trans-1,2-DCE; 1,1-DCE; and 1,1-DCA) chlorinated solvents is occurring beneath and immediately to the east of the Aubrey manufacturing building.. Aerobic decay of vinyl chloride may be occurring on the east side of the site and downgradient of the site.

2.4 *GROUND WATER MANAGEMENT ZONE AND ALTERNATIVE GROUND WATER STANDARDS*

ERM EnviroClean attempted to: (1) delineate a three-dimensional GMZ that encompasses the ground water exceeding the applicable ground water standards at the Aubrey site, and (2) define alternative standards for the ground water in the GMZ. However, the recent inconsistencies in the metal concentrations in the upper water-bearing interval has produced uncertainty in the horizontal extent of ground water exceeding the Class I standards for lead, chromium and nickel. Because of the recent data inconsistencies, ERM EnviroClean proposes to evaluate the next four rounds of monitoring data before defining the GMZ and alternative ground water standards. The additional data will provide a composite data set that can be evaluated statistically to define a GMZ having an acceptably low level of uncertainty.

2.5 *UPDATED NATURAL ATTENUATION ASSESSMENT AND TIER 3 CONTAMINANT TRANSPORT MODELING*

ERM EnviroClean used the new hydrogeologic and ground water contaminant data to update the natural attenuation assessment and Tier 3 contaminant modeling presented in Addendum No. 2. The premise and conclusions of the original assessment and modeling have not changed; however, the additional data provides confirmation of the original conclusions.

The American Society for Testing and Materials (ASTM) Remediation by Natural Attenuation Group prepared a "Draft Guide for Remediation by Natural Attenuation at Petroleum Release Sites" (ASTM, 1996), which adopted the National Resource Council's "lines of evidence" strategy for demonstration of intrinsic bioremediation. That document defines the following three "lines of evidence":

- Primary Line of Evidence - Plume status.
- Secondary Line of Evidence - Estimates of natural attenuation rates based on temporal and/or spatial contaminant trends, and geochemical indicators of natural occurring biodegradation.
- Optional Lines of Evidence - More rigorous data interpretation such as modeling, estimates of assimilative capacity, and microbiological studies.

Intrinsic bioremediation at the Aubrey site was assessed following the "line of evidence" approach as presented in the draft ASTM standard. The assessment included examination of primary and secondary lines of evidence and ground water contaminant transport modeling.

2.5.1 *Primary Line Of Evidence*

At a hazardous substance release site, the hazardous compounds that migrate from the source area into ground water are ultimately transported by ground water, creating a plume. The plume will expand until it reaches an equilibrium when the rate of contaminant contributed from the source is in balance with the rate of natural attenuation. At equilibrium, the plume stabilizes. When the source area is depleted to the point that the rate of natural attenuation exceeds the source input, the result will be shrinking of the plume over time. Plume status can be evaluated by constructing concentration contour maps and by monitoring downgradient concentrations. Changes in the distribution of concentrations and downgradient concentrations over time can be evaluated to determine the plume status.

Five sets of ground water data from the Aubrey site can be used to assess changes in the size and composition of the entire ground water plume (i.e., the second quarter 1995, fourth quarter 1995, second quarter 1996, second quarter 1997 and second quarter 1998 monitoring data). The other sets of monitoring data are not used in the analysis because they include low-biased data resulting from incomplete well or analytical parameters. An analysis of the acceptable ground water data shows a reduction in the total VOC concentrations in the interior of the ground water plume over time. The total VOC concentrations in the upper water-bearing interval are based on the concentrations detected in monitoring wells MW-5, MW-6, MW-7, MW-8S, MW-11, MW-12, MW-13S, MW-15, MW-16, MW-17S and MW-18S. The data from MW-9S was excluded from the evaluation because a pumping test performed in the well in February 1998 produced a short-term increase in VOC concentrations that is unrelated to the plume's natural degradation processes. The lower interval concentrations are based on data from monitoring wells MW-9D, MW-10, MW-13D, MW-14 and MW-18D. As shown on Figure 5, the total VOC concentrations in the upper and lower water-bearing intervals have decreased over the past 2.5 years, demonstrating that natural attenuation of the plume is occurring at the Aubrey site.

2.5.2 *Secondary Lines Of Evidence*

Secondary lines of evidence include estimating natural attenuation rates on the basis of temporal and/or spatial contaminant trends. ERM-EnviroClean estimated these natural attenuation rates by using spatial trends. Concentration contour lines were developed for TCE; cis-1,2-DCE; 1,1-DCE; and vinyl chloride by using two-dimensional kriging of the ground water data collected from monitoring wells on June 1998. Kriging is the mathematical process recognized by the USEPA as the appropriate method for interpolation and extrapolation of measured geologic data (i.e., kriging is the preferred method to estimate the distribution of contamination at a site).

For the natural attenuation rate analysis at the Aubrey site, ERM-EnviroClean used monitoring well data to plot isopleth maps for the upper water-bearing interval. The data points are too sparse for a meaningful assessment of the lower water-bearing interval. Chlorinated solvent concentrations versus distance downgradient parallel to ground water flow was plotted for the upper water-bearing interval from MW-9S to Railroad Creek (i.e., the compliance point) for TCE; cis-1,2-DCE; and vinyl chloride; and from ME-13S to the creek for 1,1-DCE. These plots, which are illustrated on Figure 6, show a steady downgradient reduction in the concentration of all the chlorinated solvent species. While the downgradient reduction in chlorinated solvent concentrations shown in Figure 6 does not prove that contaminant destruction is occurring, it demonstrates that a complete pathway for natural attenuation exists in the upper water-bearing interval.

Although a similar analysis of the lower water-bearing interval is not reasonable with the existing data set, it can be inferred that the same natural attenuation processes are working in that deeper water-bearing interval because the physical and chemical conditions in the lower interval are similar to those of the upper water-bearing interval.

Graphical regression techniques were used to estimate the natural attenuation rates for each compound. The graph of the log of the ground water concentration along the primary flow path of a stable plume will be a negatively sloped straight line. The slope of that line is the reciprocal of the attenuation distance. If the slope is multiplied by the ground water velocity, the result is the attenuation rate (ASTM, 1996). The slopes and correlation coefficients for each of the ground water concentration plots are shown on Figure 6.

Each of the chlorinated solvent species degrades at a different rate depending upon the physical, chemical and biological conditions of the subsurface environment. For example, biodegradation of TCE; TCA; cis-1,2-DCE; trans-1,2-DCE; 1-1-DCE; and 1,1-DCA occurs more readily in anaerobic conditions than aerobic conditions. Conversely, biodegradation of vinyl chloride occurs more readily in aerobic conditions. Based on their depth and permeability, it is likely that the basal, lower, and western portion of the upper water-bearing intervals (i.e., Tiskilwa Member deposits) exhibit anaerobic conditions. Whereas aerobic conditions likely occur in the sand and gravel deposits (Henry Formation) that comprise the eastern portion of the upper water-bearing interval. Evidence of these varying biodegradation rates is demonstrated by the presence of vinyl chloride in the upgradient glacial tills of the Tiskilwa Member and its near absence in the downgradient sand and gravel of the Henry Formation. It appears that aerobic biodegradation of the parent products and first-stage daughter products is occurring in the upgradient Tiskilwa Member deposits while aerobic biodegradation of vinyl chloride is primarily occurring in the downgradient Henry Formation deposits.

2.5.3 *Tier 3 Contaminant Transport Modeling*

ERM EnviroClean used a one-dimensional, advection model to estimate potential future contaminant concentrations at Railroad Creek. Railroad Creek is used as the compliance point because: (1) the SWQC are applicable at the creek and (2) the GMZ will likely extend to the creek. The contaminant transport model describes ground water advection, contaminant retardation and biodegradation. ERM EnviroClean conservatively assumed that contaminant dispersion due to mixing in porous media pore space is negligible, and did not include it in the contaminant transport model.

Although ERM EnviroClean calculated site-specific degradation (attenuation) rates, the more conservative first-order degradation rates in 35 IAC 742 Appendix C, Table E were used in the contaminant transport model. The contaminant transport model and the site-specific parameters used in the model are described in Appendix B.

The contaminant transport model was used to predict the concentrations of TCE; cis-1,2-DCE; 1,1-DCE; and vinyl chloride that could reasonably be expected to occur at Railroad Creek based on transport of the contaminant concentrations detected in the upper and lower-water-bearing intervals. Conservatively, ERM EnviroClean assumed that all of the TCE would degrade to cis-1,2-DCE and 1,1-DCE; and that all of the TCE; cis-1,2-DCE; and 1,1-DCE would degrade to vinyl chloride at the source with no attenuation. ERM EnviroClean used a conservative model to ensure that the SWQC will not be exceeded in Railroad Creek and the Class II ground water standards will not be exceeded in the lower water-bearing interval beneath the creek. As shown in Appendix B, the transport model predicts no exceedances of the SWQC or Class II ground water standards based on the concentrations detected in the June 1998 samples obtained from the monitoring wells.

The results of this natural attenuation assessment and Tier 3 contaminant transport modeling demonstrate that natural attenuation of the ground water plume at the Aubrey site is a feasible remedial alternative that is protective of human health and the environment provided that certain institutional controls are instituted and monitoring of the plume continues. The activities needed to continue monitoring the natural attenuation of the ground water plume and institute the necessary institutional controls are described in Section 3.0 of this document.

3.0 WORK PLAN ADDENDUM NO. 3

This addendum describes modifications to the tasks presented in Addendum No. 2 for the closure of the former surface impoundment. ERM EnviroClean proposes to perform Task 5 - Confirmatory Ground Water Sampling, as described in Addendum No. 2. However, we propose modifying the following tasks:

- Task 2 - Monitoring Well Installation,
- Task 3 - Ground Water Sampling and Analysis,
- Task 4 - Determination of Ground Water Standards and Ground Water Management Zone, and
- Task 7 - Remediation System Design and Implementation.

Pending approval from the IEPA, this addendum will become part of the Closure Plan for the former surface impoundment.

3.1 TASK 2 - MONITORING WELL INSTALLATION

ERM EnviroClean proposes to delete Task 2 from the Closure Plan for the reasons stated in Section 2.1.1 of this document.

3.2 TASK 3 - GROUND WATER SAMPLING AND ANALYSIS

ERM EnviroClean proposes to modify Task 3 of the Work Plan as follows:

- The monitoring wells (MW-19S, MW-19D, MW-20S, MW-20D, MW-21S and MW-21D) deleted from Task 2 will not be added to the monitoring network and sampled as indicated in Addendum No. 2.
- Beginning with the first quarter 1999 sampling event, the annual ground water sampling analyses identified on Table 1 will be performed during the first quarter instead of the second quarter. This change is necessary because the monitoring frequency will be semi-annual in 1999; therefore, no sampling will be performed in the second quarter 1999.

- Beginning with the first quarter 1999 sampling event, the ground water samples will not be analyzed for the following inorganics: arsenic, barium, cadmium, copper, cyanide, mercury, selenium, silver and zinc. These inorganics are being deleted from the sampling parameter list because they have not been detected at concentrations exceeding the applicable ground water standards during the past five sampling events. As such, they pose no risk to ground water and are not constituents of concern for the site. Additional monitoring for these inorganics is unnecessary.

3.3 *TASK 4 - DETERMINATION OF GROUND WATER STANDARDS AND GROUND WATER MANAGEMENT ZONE*

ERM EnviroClean proposes to modify Task 4 of the Work Plan as follows:

- The ground water monitoring data from 1997, 1998, 1999 and the first quarter of 2000 will be statistically evaluated to identify outliers and then the acceptable data (i.e., without outliers) will be compared to the applicable ground water standards to delineate the GMZ and define alternative ground water standards in accordance with the requirements of 35 IAC 620.250 and 35 IAC 620.450, respectively.

- Aubrey will propose institutional controls that comply with 35 IAC 742, Subpart J to eliminate the ground water ingestion pathway for the impacted ground water within the GMZ.

- The results of the Task 4 activities will be documented in Corrective Action Status Report and Work Plan Addendum No. 4, and the report will be submitted to the IEPA for review and comment.

3.4 *TASK 7 - REMEDIATION SYSTEM DESIGN AND IMPLEMENTATION*

After institutional controls that comply with 35 IAC 742, Subpart J are in place, ERM EnviroClean proposes to delete Task 7 from the Work Plan because the Tier 3 evaluation of the ground water plume (Appendix B) demonstrates that protection of human health and the environment can be achieved through natural attenuation of the ground water plume and institutional controls. Therefore, the design and implementation of an active remediation system is unnecessary after the necessary institutional controls are in place.

4.0 *PROJECT SCHEDULE*

Aubrey is committed to implementing the work described in this document in an environmentally sound and cost-effective manner . The Task 3 activities will be performed in accordance with the approved schedule described in Addendum No. 2. The Task 4 activities are dependent upon completion of the Task 3 activities through the first quarter of 2000. Therefore, completion of Task 4 and transmittal of Corrective Action Status Report and Work Plan Addendum No. 4 is scheduled for May 26, 2000.

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